AERA Symposium:  
Formative Assessment and Learning 
Progression Approaches to Assessing Science and Language Learning of English Learners

Chair: Alison Bailey (UCLA)  
Discussant: Louise C. Wilkinson (Syracuse University)

1. Assessments of Science & Literacy Integrated Curricula  
   (Yukie Toyama & Mark Wilson)

1. Formative Assessment: Science & Language with English Learners  
   (Amelia Gotwals, MSU)

2. Assessing Scientific Genres of Explanation, Argumentation, & Prediction  
   (Wendy Ranae Johnson, Kentwood Public Schools, Beth A. Covitt, Univ. of Montana, Charles Anderson, MSU)

3. Commentary: The Promise of Learning Progressions for the Integration of Science & Language Assessment  
   (Alison Bailey, UCLA & Margaret Heritage, WestEd)
Formative Assessments in Integrated Science & Literacy Curricula: A Suggested Alternative Approach

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AERA 2019
Formative Assessments

• Generate **feedback** to inform & modify teaching & learning (Black, Wilson & Yao, 2011)

• Student responses need to be collected & **interpreted spontaneously**

• Teachers need an idea of **how learning progresses** from a low level to a higher level in a particular domain

→ Teachers and students need **learning progression** or **a roadmap**.
Science-Literacy Integrated Curricula Reviewed

- Concept Oriented Reading Instruction (John Guthrie)
- Guided Inquiry Supporting Multiple Literacies (Palincsar & Magnusson)
- Promoting Science Among ELLs (Okhee Lee)
- Quality English and Science Teaching (Center for Applied Linguistics)
- Reading Apprenticeship (WestEd)
- Seeds of Science / Roots of Reading (Lawrence Hall of Science)

CREATE: Project QuEST
(Quality English and Science Teaching)

Impact of a Large-Scale Science Intervention Focused on English Language Learners

Lorena Llona
Okhee Lee
New York University
Feng Jiang
University of Arkansas
Alison Haas
Corey O’Connor
Christopher D. Van Booven
Michael J. Kieffer
New York University

Concept-Oriented Reading Instruction

Roots of Reading

Seeds of Science
Main Findings from the Curricula Review

1. Strong link between Curriculum & Instruction

2. Majority of assessments is **summative** & **distal** in nature. Hard to find formative assessments

   2a. Even when formative tools exist, little support for interpretation & actions

3. Weak Curriculum–Assessment & Instruction–Assessment Links

   → Assessment tasks are not well aligned with the curricular goals
   → Targeted feedback not possible with total scores generated from multiple-choice items
The theory is first posed as a hypothesis (based on the literature and professional judgments) and then needs to be empirically validated with responses to the assessment.
How can we develop assessments that reflects the suggested formative triangle?

The BEAR Assessment System

With examples from the middle school science curricula called Issues, Evidence and You (IEY, Wilson & Slone, 2000)
The BEAR Assessment System

Can be applied to both formative & summative assessments

BASS (the BEAR Assessment System Software) supports the entire assessment cycle on most platforms.
1. Develop a Construct Map that Shows Progression

Example Construct Map: *Using Evidence*

<table>
<thead>
<tr>
<th>Anchor Points</th>
<th>Responses to Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Response accomplishes lower level AND goes beyond in some significant way, such as questioning or justifying the source, validity, and/or quantity of evidence.</td>
</tr>
<tr>
<td>4</td>
<td>Response provides major objective reasons AND supports each with relevant &amp; accurate evidence</td>
</tr>
<tr>
<td>3</td>
<td>Response provides some objective reasons AND some supporting evidence, BUT at least one reason is missing and/or part of the evidence is incomplete.</td>
</tr>
<tr>
<td>2</td>
<td>Response provides only subjective reasons (opinions) for choice and/or uses inaccurate or irrelevant evidence from the activity</td>
</tr>
<tr>
<td>1</td>
<td>No response; illegible response; response offers no reasons AND no evidence to support choice made.</td>
</tr>
</tbody>
</table>

Typically you need a few construct maps to represent a curriculum.
2. Develop Assessment Items & Instructional Activities that Elicit Responses to be Placed on Each Point along the Construct Map

IEY-Formative Assessment Task Example

You are a public health official who works in the Water Department. Your supervisor has asked you to respond to the public’s concern about water chlorination at the next City Council meeting. Prepare a written response explaining the issues raised in the newspaper article. Be sure to discuss the advantages and disadvantages of chlorinating drinking water in your response, and then explain your recommendation about whether the water should be chlorinated.

Ordered Multiple Choice Example (Briggs et al., 2006)

It is most likely colder at night because

A. the Earth is at the furthest point in its orbit around the Sun. Level 3
B. the Sun has traveled to the other side of the Earth. Level 2
C. the Sun is below the Earth and the Moon does not emit as much heat as the Sun. Level 1
D. the place where it is night on Earth is rotated away from the Sun. Level 4

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BASS supports various item formats

[5] [a] Use the values in the table to draw a graph that shows the relationship between $C$ and $t$. 
With his summer job, Jakai saved $1,500 for the upcoming school year. He plans to spend a constant amount of money each month for the next 10 months.

He does not want to run out of money. He modeled the situation with the following equation:

\[ y = 1500 - 150x \]

Each of the symbols and numbers in this equation represents a “real-life” component of this situation.

[1] Match each symbol and number to the “real-life” component that it represents.

(Note: Drag only one component into each box. You will have leftover components that are not represented in the problem. If you make a mistake, you can drag the component back to the top or into a different box. Your answer is not “locked in” until you hit “Next” at the bottom of this page.)

- The total amount of money Jakai saved.
- Jakai’s remaining savings after a given number of months.
- Number of months.
- The change in Jakai’s savings.
- Jakai’s monthly spending.

\[ y \quad -150 \quad x \quad 1500 \]
3. Define Outcome Space that Enables Teachers to Interpret Student Responses against the Construct Map

Scoring guides are similar to “rubrics” but they are all tied to a construct map.

- Increased coherence between the learning theory & actual student responses
- Increased efficiency for teachers to notice qualitative differences and score them
4. Use a Measurement Model that Helps Interpret Scored Responses against the Construct Map

**A Progress Map for Students’ Performance on Conducting Investigations construct**

<table>
<thead>
<tr>
<th>Construct Levels</th>
<th>Students</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 - Advanced</td>
<td>Michaels</td>
<td>Activity 12.4 7.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Activity 5.4 16.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Activity 18.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Activity 12.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Activity 7.3</td>
</tr>
<tr>
<td>3 - Correct</td>
<td>Brown</td>
<td>Activity 5.3</td>
</tr>
<tr>
<td></td>
<td>Johnson</td>
<td>Activity 16.3</td>
</tr>
<tr>
<td></td>
<td>Andrews</td>
<td>Activity 18.3</td>
</tr>
<tr>
<td></td>
<td>Simon</td>
<td>Activity 12.2</td>
</tr>
<tr>
<td></td>
<td>Alexander</td>
<td>Activity 7.2</td>
</tr>
<tr>
<td></td>
<td>Thomason</td>
<td>Activity 5.2</td>
</tr>
<tr>
<td>2 - Incomplete</td>
<td>Williams</td>
<td>Activity 16.2</td>
</tr>
<tr>
<td></td>
<td>Johnson</td>
<td>Activity 18.2</td>
</tr>
<tr>
<td></td>
<td>McClaren</td>
<td>Activity 12.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Activity 7.1</td>
</tr>
<tr>
<td>1 - Incorrect</td>
<td></td>
<td>Activity 16.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Activity 18.1</td>
</tr>
</tbody>
</table>

- Activity 12.4 = difficulty of achieving Level 4 “advanced” in Activity 12
- Michael has 50%+ of chance achieving Level 3 “Correct” in Activities 5, 16, 18
4. Use a Measurement Model that Helps Interpret Scored Responses against the Construct Map (conti.)

- A measurement model provides evidence for validity, reliability, and fairness of the assessment
The BEAR Assessment System

Four building blocks are not necessarily four sequential steps.

Going back and forth between blocks is typical. The developer goes through multiple cycles.
Mapping a Learning Progression with Construct Maps

Levels of Learning Progression ≅ Levels of a Single Construct

Hypothesized learning progression

A Construct Map
A Link Exists at Certain Points across Different Construct Maps
Does Learning Progression (LP) Differ between ELs and non-ELs?

Different Possibilities:

No

- ELs tend to be at lower points than their native-English speaking peers.
- Some items developed based on the LP behave differently for ELs as compared to non-ELs who have the matching ability being measured → Differential item functioning

Yes

- ELs are on a different learning progression from those of non-ELs → Variation among ELs is also possible
Summary

1. A developmental theory of learning in a particular domain is largely missing in existing integrate curricula.

2. Lack of the theory or learning progression leads to lack of coherence among curriculum, instruction, and assessment.
   - Assessments not fulfill their full potential in generating formative feedback to teachers and students.

3. Our suggested approach enables the construction and empirical validation of formative assessments and underlying learning progression.

4. Our approach also helps investigate complex issues such as:
   - Examine relationships among science & literacy/language constructs and map them as a learning progression.
   - Variation in learning progression between ELs and non-ELs.
Thank you

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